

FIG. 1

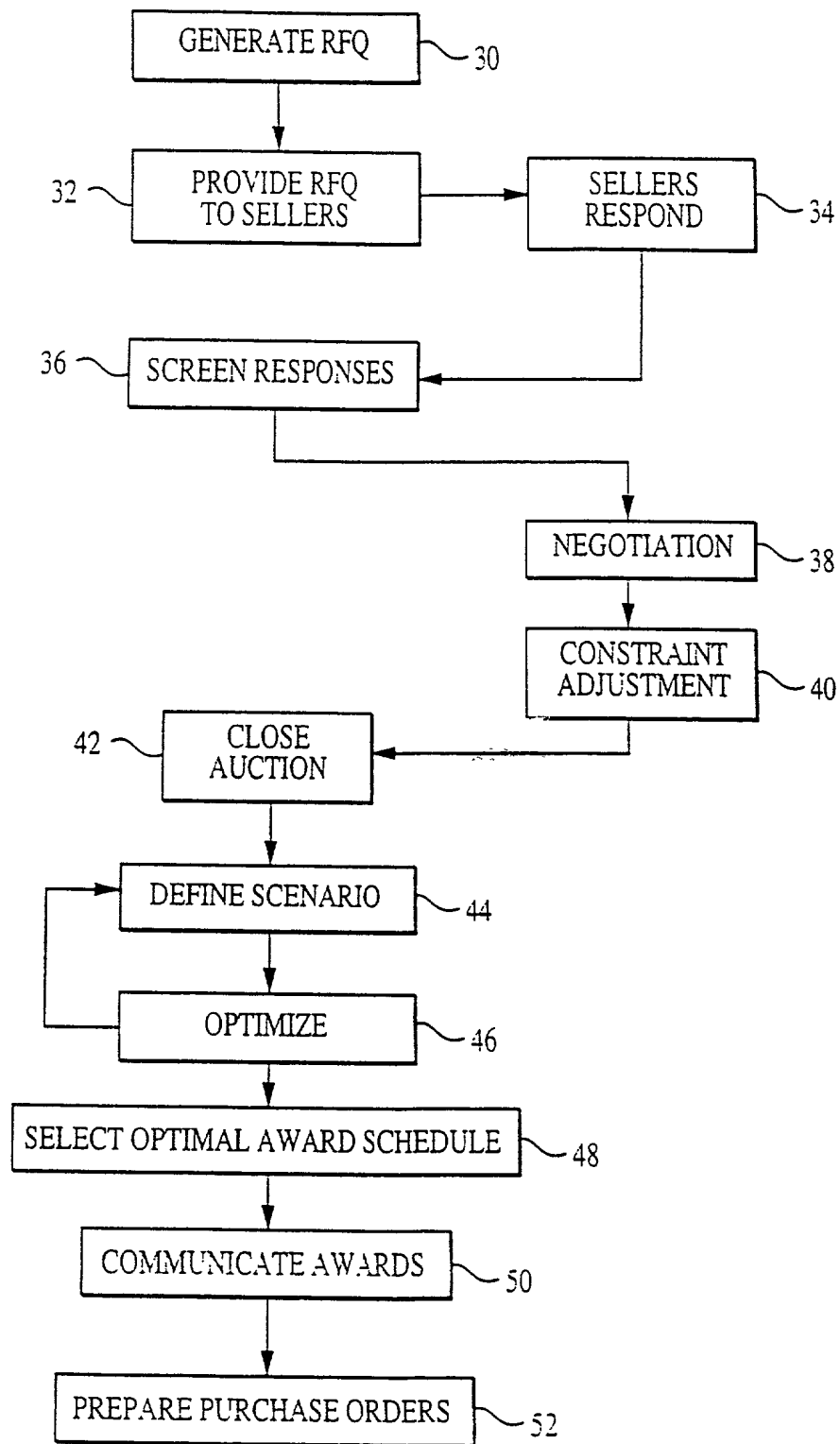


FIG. 2

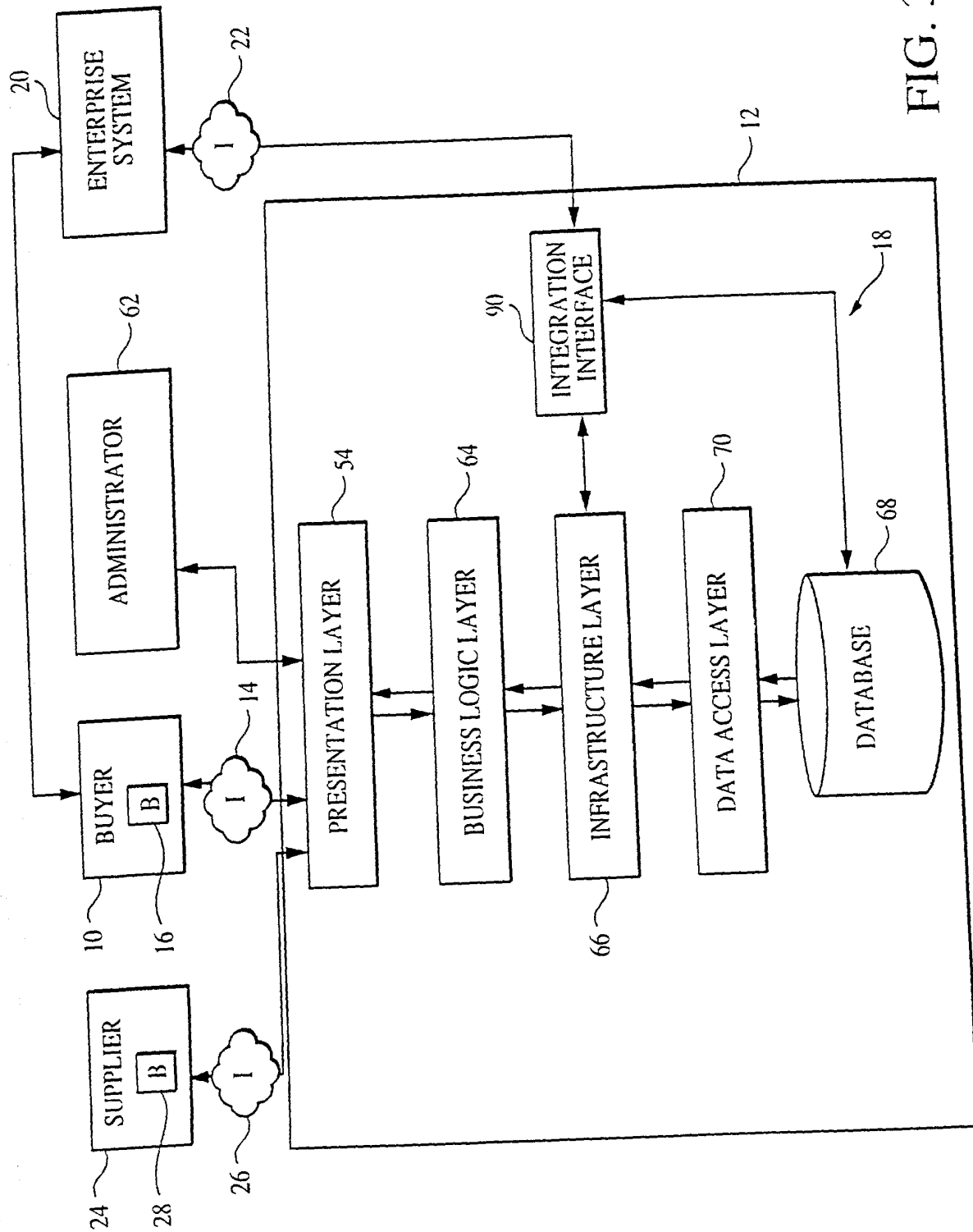


FIG. 3

FIG. 4

The diagram illustrates a system architecture with the following components and connections:

- External Systems (12):**
 - Supplier (28)** and **Buyer (16)** are connected to a central cloud (14).
 - Administrator (62)** and **Enterprise System (20)** are connected to a central cloud (22).
- Workspaces (66):**
 - Supplier Workspace (58)**, **Buyer Workspace (56)**, and **Administrator Workspace (54)** are connected to a central cloud (60).
- Engines and Services (80):**
 - Workflow Engine (72)**, **Bidding Engine (74)**, **Optimization Engine (76)**, and **Supplier Performance Engine (80)** are connected to a central cloud (64).
 - The **Optimization Engine (76)** is connected to a **CPLEX (78)** block.
 - The **Bidding Engine (74)** is connected to an **Integrated Messaging Service (82)**, **Transaction Management Service (86)**, and **Session Management Service (88)**.
 - The **Supplier Performance Engine (80)** is connected to an **XML Integ (92)**, **Java API (94)**, and **RMS API (96)**.
- Data Access (70):**
 - The **XML Integ (92)** is connected to a **Data Access (70)** block.
 - The **Data Access (70)** block is connected to a **Databases (68)** block.

[illegible]

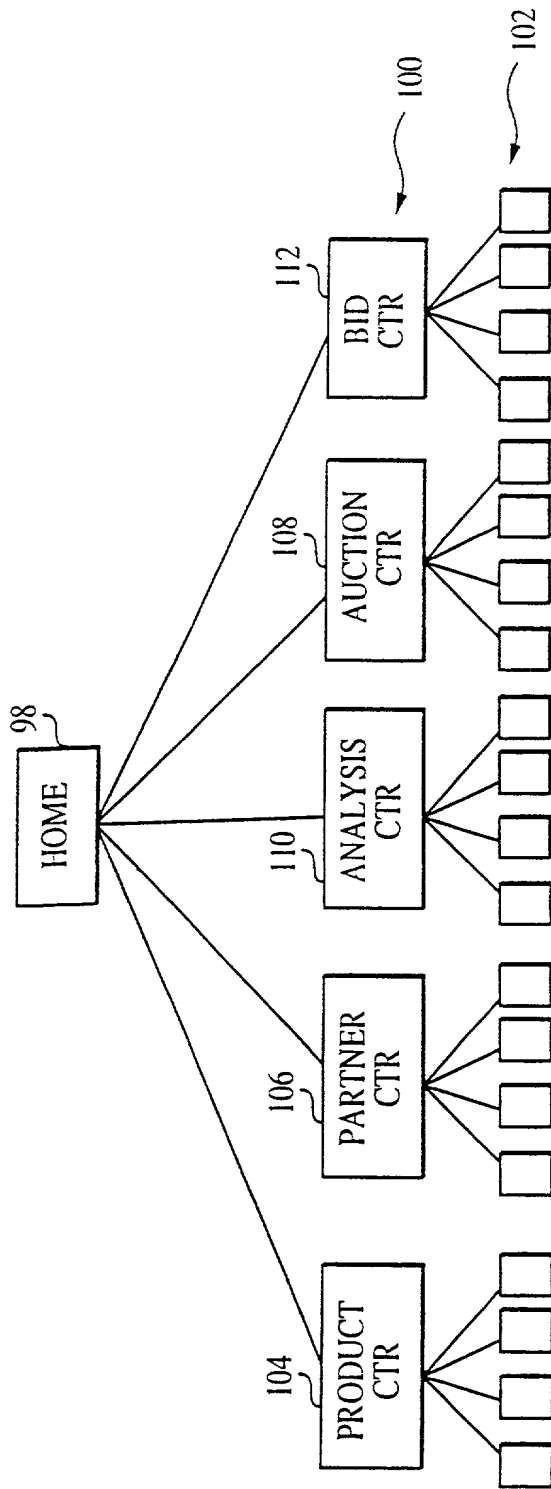


FIG. 5

Applicant(s): Avner Schneur et al.

AUCTION MANAGEMENT WITH BUSINESS VOLUME
DISCOUNT

Microsoft Internet Explorer


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Address: http://qa03/en/index.html

Registration Form

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[Buyer Home](#)

[Supplier Home](#)

Please fill in the following for (* indicating required fields):

Organization Information:

Organization Type (*):	Seller ▼
Organization Name (*):	ABC Co.
Code (*):	ABCCO
Description (*):	ABC Electronics
URL (*):	http://www.doil.com

Default Organization User:

Login Name (*):	ABCSeller
Name (*):	AI Tradings
Email Address (*):	ai@bigbuy.com
Fax Number	
Phone Number (*):	123-123-1234
Select Password (*):
Re-enter password (*):

Local intranet

FIG. 6

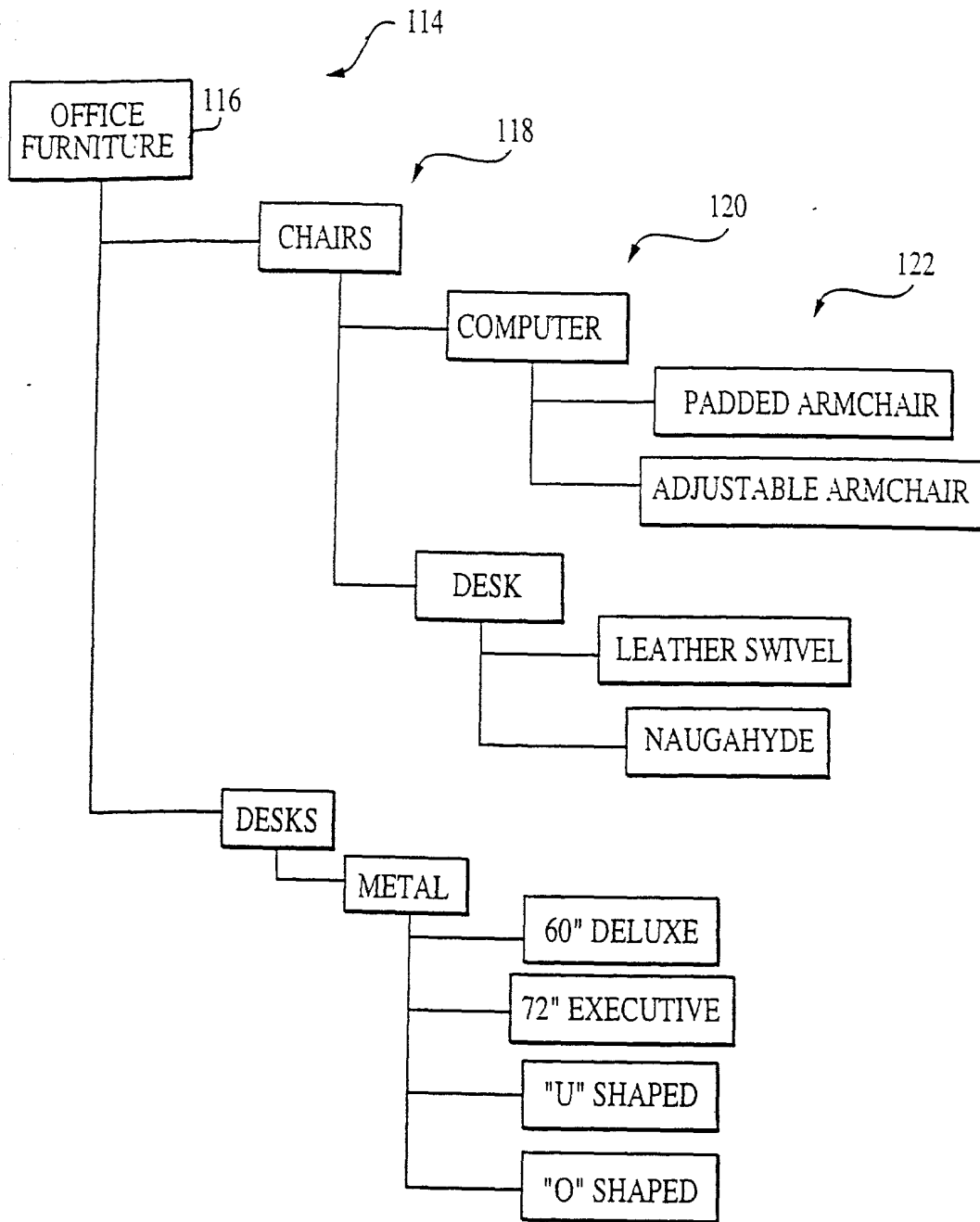


FIG. 7

ePass - Microsoft Internet Explorer		File Edit View Favorites Tools Help	
Back	Forward	Stop	
Address http://qa03/en/index.html		Search	History
Refresh	Home	Favorites	Mail
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ePass

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[Buyer Home](#)
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[Configure Partners](#)
[Manage Auctions](#)
[View Bids](#)
[Analyze Bids](#)
[Logout](#)

Home > [Auction Center](#) > [Auction: Electrical](#) > [Auction Configuration: Step 4: Bid Attributes](#)

Step 1: Setup Auction	Step 2: Format Parameters	Step 3: Item Attributes	Step 4: Bid Attributes	Step 5: Bidders	Step 6: Notes	Auction Summary
<p>Auction: Electrical</p> <p>Please configure the information fields you would like Partners to provide as part of their bids. To add a new attribute, define the name in the text box and click Add Attribute. To delete an attribute from the list, check-select the item and click Delete Attribute.</p>						
<div style="display: flex; align-items: center;"> <input type="checkbox"/> Warranty Days </div>						
<div style="border: 1px solid black; padding: 5px; min-height: 30px;"> Bid Parameters </div>			<div style="display: flex; align-items: center;"> <div style="flex-grow: 1;">New Attribute Name:</div> <div style="border: 1px solid black; width: 150px; height: 25px;"></div> </div>			
			Add Attribute		Delete Attributes	

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FIG. 9

Microsoft Internet Explorer

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Address http://qa03/en/index.html

Home > Partner Center > Category Rating > Category Rating Edit

Partner: ABC Traders
Category: Electronics

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Edit Partner Category Rating

The following are the Participant performance factor ratings for category Electronics
To modify, make changes in the form and click **Save**.
Valid values are from 1 to 100 (Worst to Best).

Name	Code	Description	Default Value	Partner Rating
Quality	Q1	Quality Rating	50	50
				96

Save Cancel

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FIG. 10

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Address http://qa03/en/index.html Go Link >>

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Home > Auction Center

[View Created Auctions](#)
[View Pending Auctions](#)
[View Open Auctions](#)
[View Closed Auctions](#)
[View Awarded Auctions](#)
[Import/Export](#)

The following is the list of Created Auctions you have offered or currently offering. Click on the Auction id or description to bring up the Auction status report. Click on the action links for other Auction features.

	Name	Type	Open	Close	Actions
<input type="checkbox"/>	Supplies	Dutch			Open Auction
<input type="checkbox"/>	Electrical	Sealed			Open Auction
<input type="checkbox"/>	test1	Sealed			Open Auction
<input type="checkbox"/>	AXSAuction 1	Dutch			Open Auction

1-4 of 4

Create New Auction
Cancel Selected Auctions

- [Buyer Home](#)
- [Message Center](#)
- [Manage Products](#)
- [Configure Partners](#)
- [Manage Auctions](#)
- [View Bids](#)
- [Analyze Bids](#)
- [Logout](#)

[Help](#)

http://qa03/en/b auction start.jsp?forward=/en/b auction man isp?action=list&cur_id=1007&epass_session=abuyer_95 Local intranet

FIG. 11

20020714T12007

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File Edit View Favorites Tools Help

Back Forward Stop Refresh Home Search Favorites History Mail Print Edit Discuss Dell Home

Address http://qa03/en/index.html

Go Link >

Home > [Auction Center](#) > Supplies

Auction Dates

Open Auction for bidding

Populate the dates below to specify the opening and closing time of the auction. When done, click **Open Later** to update the database. Click **Cancel** to cancel any changes. The **Now** buttons will put today's date into the corresponding date selection lists. Click **Open Right Now** to open the auction immediately.

The following rules apply:

1. An auction can NOT be started if:
 - a. You do not have management privileges.
 - b. There are no requisitions or items defined for the auction.
 - c. If the auction is a sealed type and there are no Participants approved for the auction.
2. Opening date can not be modified if the auction has already started.
3. Closing date does not have to be specified.
4. The closing date cannot be before the opening date.

Open Date	Close Date	Month	Day	Year	Hour	Minute	Open Later	Cancel	Open Right Now
May	Jun	May	11	2000	12	00	Open Later	Cancel	Open Right Now
Now	Now	Now	Now	Now	Now	Now	Now	Now	Now

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Buyer Home

Message Center

Manage Products

Configure Partners

Manage Auctions

View Bids

Analyze Bids

Logout

Help

Done

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FIG. 12

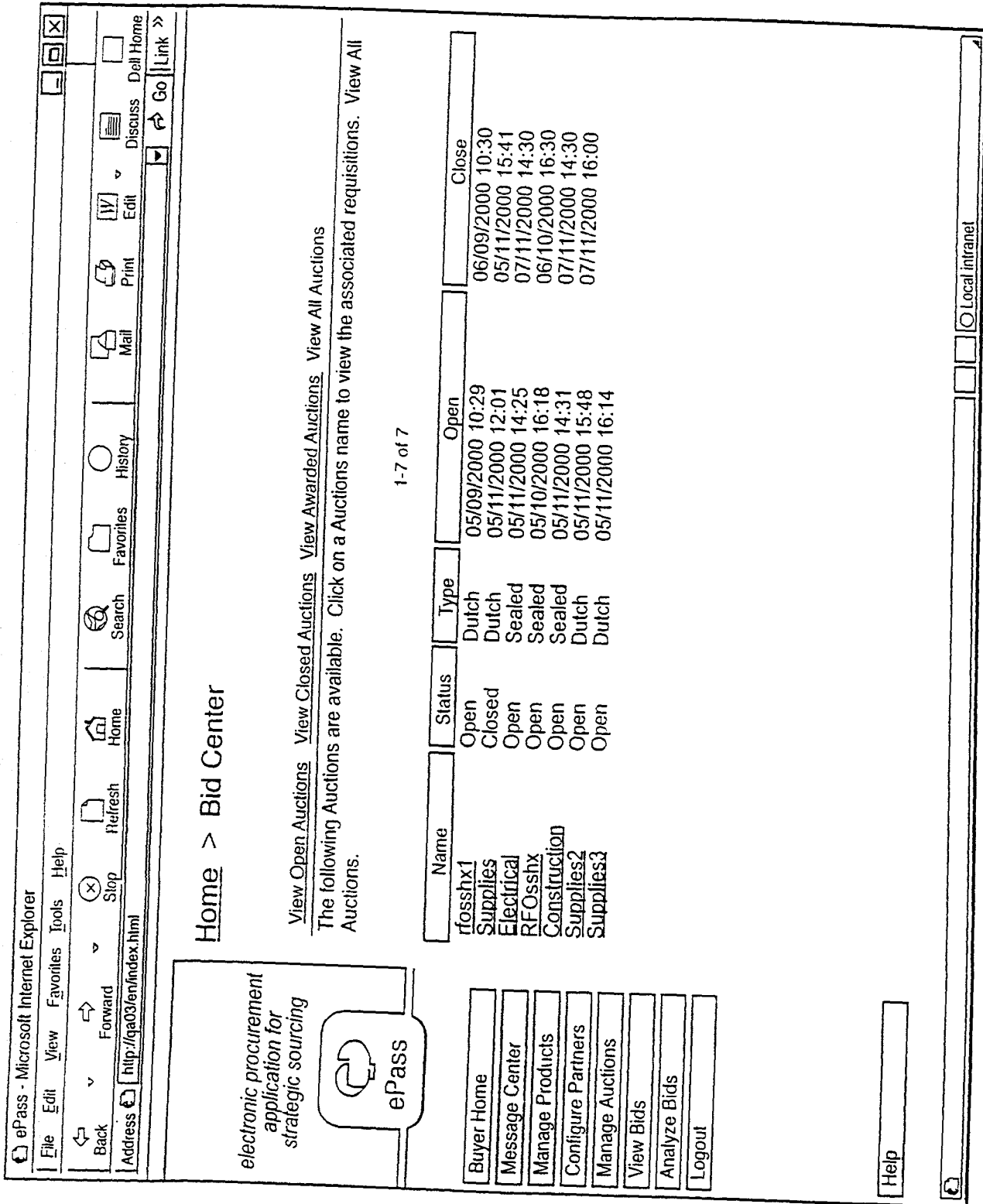


FIG. 13

Microsoft Internet Explorer


File Edit View Favorites Tools Help

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Address <http://qa03/en/index.html> Go Link >>

Home > [Bid Center](#) > [Auction Supplies2](#) > [Requisition Items: Req 1](#)

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Auction Info

Auction Name	Supplies2
Auction Status	Open
Auction Type	Dutch
Show All Bidders	No
Start Date	05/11/2000 15:48
End Date	07/11/2000 16:00

View Requisition Items

The following line items are in the requisition.

1-3 of 3

Level	Item	Type	Category	Description	Desired Qty	Price	Action
	Pencils	Single Item	sshcat1	#2 Pencils	1,000		Bid Messages
	Lined Paper	Single Item	sshcat1	8/11 Lined Paper White 100	100		Bid Messages
	Fax Paper	Single Item	sshcat1	Fax Paper 8/11	1,000		Bid Messages

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Address http://qa03/en/index.html

Product Category sshcat1 Reserved Price

Name Pencils Historical Price

Code PEN101 Minimum Bid Quantity 0

Description # 2 Pencils Maximum Bid Quantity

Minimum Desired Quantity 1,000

Maximum Desired Quantity

Price Quote Unit

Lot Size

Required Delivery Date

View Bids

The following are the current bids for this item.

0 of 0

Bidder Bid Type Max Bid Quantity Price per Unit

Enter Bid for the item

Enter the price per Unit and any other fields before clicking the Submit button:

Partner Product Code PENz10

Comment In Stock

Maximum 1000 Price Per Unit 105

Save Cancel

Supplier Home

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FIG. 14

FIG.
15A

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 Address http://qa03/en/index.html

Home > Bid Center > Auction Supplies2 > Requisition: Req 1 > Item: Pencils

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Auction Info Auction Name: Supplies2 Auction Status: Open Auction Type: Dutch Show All Bidders: No Start Date: 05/11/2000 15:48 End Date: 07/11/2000 16:00		Item Details Product Category: sshcat1 Name: Pencils Code: PEN101 Description: # 2 Pencils Minimum Desired Quantity: 1,000 Maximum Desired Quantity: Price Quote Unit: Lot Size: Required Delivery Date:		Reserved Price Historical Price Minimum Bid Quantity: 0 Maximum Bid Quantity:
Lowest Bid Bidder: 7 Max Bid Quantity: 1,000 Price Per Unit: \$0.05 Highest Bid Allowed: \$0.04		View Bids The following are the current bids for this item.		

Buyer Home
 Message Center
 Manage Products
 Configure Partners
 Manage Auctions
 View Bids
 Analyze Bids
 Logout

Help

Done

FIG.
15B

Microsoft Internet Explorer

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 Configure Partners
 Manage Auctions
 View Bids
 Analyze Bids
 Logout

Start Date: 05/11/2000 15:48
 End Date: 07/11/2000 16:00

Item Details

Product Category	sshcat1	Reserved Price
Name	Pencils	Historical Price
Code	PEN101	Minimum Bid Quantity
Description	# 2 Pencils	Maximum Bid Quantity
Minimum Desired Quantity	1,000	
Maximum Desired Quantity		
Price Quote Unit		
Lot Size		
Required Delivery Date		

Lowest Bid

Bidder	7
Max Bid Quantity	1,000
Price Per Unit	\$0.05
Highest Bid Allowed	\$0.04

View Bids

The following are the current bids for this item.
1-3 of 3

Bidder	Organization	Bid Type	Bundle Code*	Max Bid Quantity	Price Per Unit
Harry Sales	ABC Co	Single Item Bid		1,000	\$0.05
Ed Cation	BestDeal	Single Item Bid		1,000	\$0.05
Boe Cheaper	Surfin' Seller	Single Item Bid		1,000	\$0.06

Help

Done

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AUCTION MANAGEMENT WITH BUSINESS VOLUME
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FIG. 16A

Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Forward Stop Refresh Home Search Favorites History Mail Print Edit Discuss Dell Home
Address http://qa03/en/index.html

Home > Bid Center > Auction: Electrical > Requisition: real > Item: 30 AMP Breakers

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View Bids
Analyze Bids
Logout

Auction Info

Auction Name	Electrical
Auction Status	Open
Auction Type	Sealed
Show All Bidders	No
Start Date	05/11/2000 14:25
End Date	07/11/2000 14:30

Item Details

Product Category	sshcat1
Name	30 AMP Breakers
Code	BK30A101
Description	30 AMP Circuit Breaker
Minimum Desired Quantity	40
Maximum Desired Quantity	
Price Quote Unit	
Lot Size	
Required Delivery Date	

View Bids

The following are the current bids for this item.
1-5 of 5

Bidder	Organization	Bid Type	Bundle Code*	Min Bid Quantity	Max Bid Quantity	Price Per Unit	One Time Charge
Harry Sales	ABC Co	Single Item Bid		40	100	\$5.00	\$0.00

Ed Cation Rec Deal Rec Deal Single Item Single Item
\$4.00 \$0.00 Local Intranet

Help Done

ePass - Microsoft Internet Explorer		File Edit View Favorites Tools Help		Back Forward Stop Refresh Home Search Favorites History Mail Print Edit W Link Go >>																																																									
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Start Date	End Date																																																												
05/11/2000 14:25	07/11/2000 14:30																																																												
Item Details <table border="1"> <tr> <td>Product Category</td> <td>sshcat1</td> </tr> <tr> <td>Name</td> <td>30 AMP Breakers</td> </tr> <tr> <td>Code</td> <td>BK30A101</td> </tr> <tr> <td>Description</td> <td>30 AMP Circuit Breaker</td> </tr> <tr> <td>Minimum Desired Quantity</td> <td>40</td> </tr> <tr> <td>Maximum Desired Quantity</td> <td></td> </tr> <tr> <td>Price Quote Unit</td> <td></td> </tr> <tr> <td>Lot Size</td> <td></td> </tr> <tr> <td>Required Delivery Date</td> <td></td> </tr> </table>						Product Category	sshcat1	Name	30 AMP Breakers	Code	BK30A101	Description	30 AMP Circuit Breaker	Minimum Desired Quantity	40	Maximum Desired Quantity		Price Quote Unit		Lot Size		Required Delivery Date																																							
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Price Quote Unit																																																													
Lot Size																																																													
Required Delivery Date																																																													
View Bids The following are the current bids for this item. 1-5 of 5																																																													
<table border="1"> <thead> <tr> <th>Bidder</th> <th>Organization</th> <th>Bid Type</th> <th>Bundle Code*</th> <th>Min Bid Quantity</th> <th>Max Bid Quantity</th> <th>Price Per Unit</th> <th>One Time Charge</th> </tr> </thead> <tbody> <tr> <td>Harry Sales</td> <td>ABC Co</td> <td>Single Item Bid</td> <td></td> <td>40</td> <td>100</td> <td>\$5.00</td> <td>\$0.00</td> </tr> <tr> <td>Ed Cation</td> <td>BestDeal</td> <td>Single Item Bid</td> <td></td> <td>20</td> <td>20</td> <td>\$4.00</td> <td>\$1.00</td> </tr> <tr> <td>Boe</td> <td>Surfin' Seller</td> <td>Single Item Bid</td> <td></td> <td>1</td> <td>10</td> <td>\$5.50</td> <td>\$0.00</td> </tr> <tr> <td>Cheaper</td> <td>Surfin' Seller</td> <td>Single Item Bid</td> <td></td> <td>11</td> <td>30</td> <td>\$5.00</td> <td>\$0.00</td> </tr> <tr> <td>Boe</td> <td>Surfin' Seller</td> <td>Single Item Bid</td> <td></td> <td>31</td> <td>50</td> <td>\$3.50</td> <td>\$0.00</td> </tr> <tr> <td>Cheaper</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table>						Bidder	Organization	Bid Type	Bundle Code*	Min Bid Quantity	Max Bid Quantity	Price Per Unit	One Time Charge	Harry Sales	ABC Co	Single Item Bid		40	100	\$5.00	\$0.00	Ed Cation	BestDeal	Single Item Bid		20	20	\$4.00	\$1.00	Boe	Surfin' Seller	Single Item Bid		1	10	\$5.50	\$0.00	Cheaper	Surfin' Seller	Single Item Bid		11	30	\$5.00	\$0.00	Boe	Surfin' Seller	Single Item Bid		31	50	\$3.50	\$0.00	Cheaper							
Bidder	Organization	Bid Type	Bundle Code*	Min Bid Quantity	Max Bid Quantity	Price Per Unit	One Time Charge																																																						
Harry Sales	ABC Co	Single Item Bid		40	100	\$5.00	\$0.00																																																						
Ed Cation	BestDeal	Single Item Bid		20	20	\$4.00	\$1.00																																																						
Boe	Surfin' Seller	Single Item Bid		1	10	\$5.50	\$0.00																																																						
Cheaper	Surfin' Seller	Single Item Bid		11	30	\$5.00	\$0.00																																																						
Boe	Surfin' Seller	Single Item Bid		31	50	\$3.50	\$0.00																																																						
Cheaper																																																													
Local intranet																																																													

FIG. 17

ITEM	QTY DESIRED	BID 1 ABC CO.		BID 2 BESTDEAL		BID 3 SURFIN
2x4x8	400	400	1.25	400	1.25	400
2x12x10	1000	1000	5.00	1000	4.50	1000
PW 4x8x1/2	100	100	25.00	100	25.00	100
<u>BUNDLED @ \$7350</u>						

FIG. 18

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Address http://qa03/en/index.html					

electronic procurement application for strategic sourcing

Home > Bid Center > Auction: Construction > Requisition Items: REQ1

Auction Info

Auction Name	Construction
Auction Status	Open
Auction Type	Sealed
Show All Bidders	No
Start Date	05/11/2000 14:31
End Date	07/11/2000 14:30

View Requisition Items

The following line items are in the requisition.

Level	Selection	Item	Type	Category	Description	Desired Qty	Price	Action
	<input checked="" type="checkbox"/>	2x4x8	Single Item	sshcat1	Lumber 2 x 4 x 8 ft	400	Bid	Messages
	<input checked="" type="checkbox"/>	2x12x10	Single Item	sshcat1	Lumber 2 x 12 x 10 ft	1,000	Bid	Messages
	<input checked="" type="checkbox"/>	PW 4x8x1/2	Single Item	sshcat1	Plywood 4 x 8 x 1/2 in	100	Bid	Messages

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Select All | Unselect All | Switch All

Create Bundled Bid

Applicant(s): Avner Schneur et al.

AUCTION MANAGEMENT WITH BUSINESS VOLUME
DISCOUNT

FIG. 20A

Microsoft Internet Explorer

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Address http://ja03/en/index.html

Home > Bid Center > RFQ: Construction > Requisition: REQ1 > Create Bundled Bid

Auction Info

Auction Name	Construction
Auction Status	Open
Auction Type	Sealed
Show All Bidders	No
Start Date	05/11/2000 14:31
End Date	07/11/2000 14:30

Create Bundled Bid

Enter the product Quantity per Bundle, Price per Bundle, and any other fields before clicking the Submit button:

Bundle Description:

Seller Bundle Code	Bundle of Materials
Comment	Bundled bid for Req 1 of Construction RFQ

Bundle Composition:

Buyer		Seller	
Line Item	Name	Desired Quantity	Quantity per Bundle
020408	2 x 4 x 8	400	400
021210	2 x 12 x 20	1,000	1000
0406005	PW 4 x 8 x 1/2	100	902019

Supplier Home Message Center View Bids Logout

Help

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Create Bundled Bid

Auction type: Sealed

Show All Bidders: No

Start Date: 05/11/2000 14:31

End Date: 07/11/2000 14:30

Enter the product Quantity per Bundle, Price per Bundle, and any other fields before clicking the Submit button:

Bundle Description:

Seller Bundle Code:

Bundle of Materials:

Comment:

Bundled bid for Req 1 of Construction RFQ:

Bundle Composition:

Line Item	Name	Desired Quantity	Quantity per Bundle	Product Code	Seller
020408	2 x 4 x 8	400	400	021190	
021210	2 x 12 x 10	1,000	1000	090121	
0406005	PW 4 x 8 x 1/2	100	100	902019	

Bundle Pricing:

Number of Bundles	Cost
Minimum	Price per Bundle
Maximum	One-Time Charge
1	7350

Save Cancel

Local intranet

FIG. 20B

FIG. 21

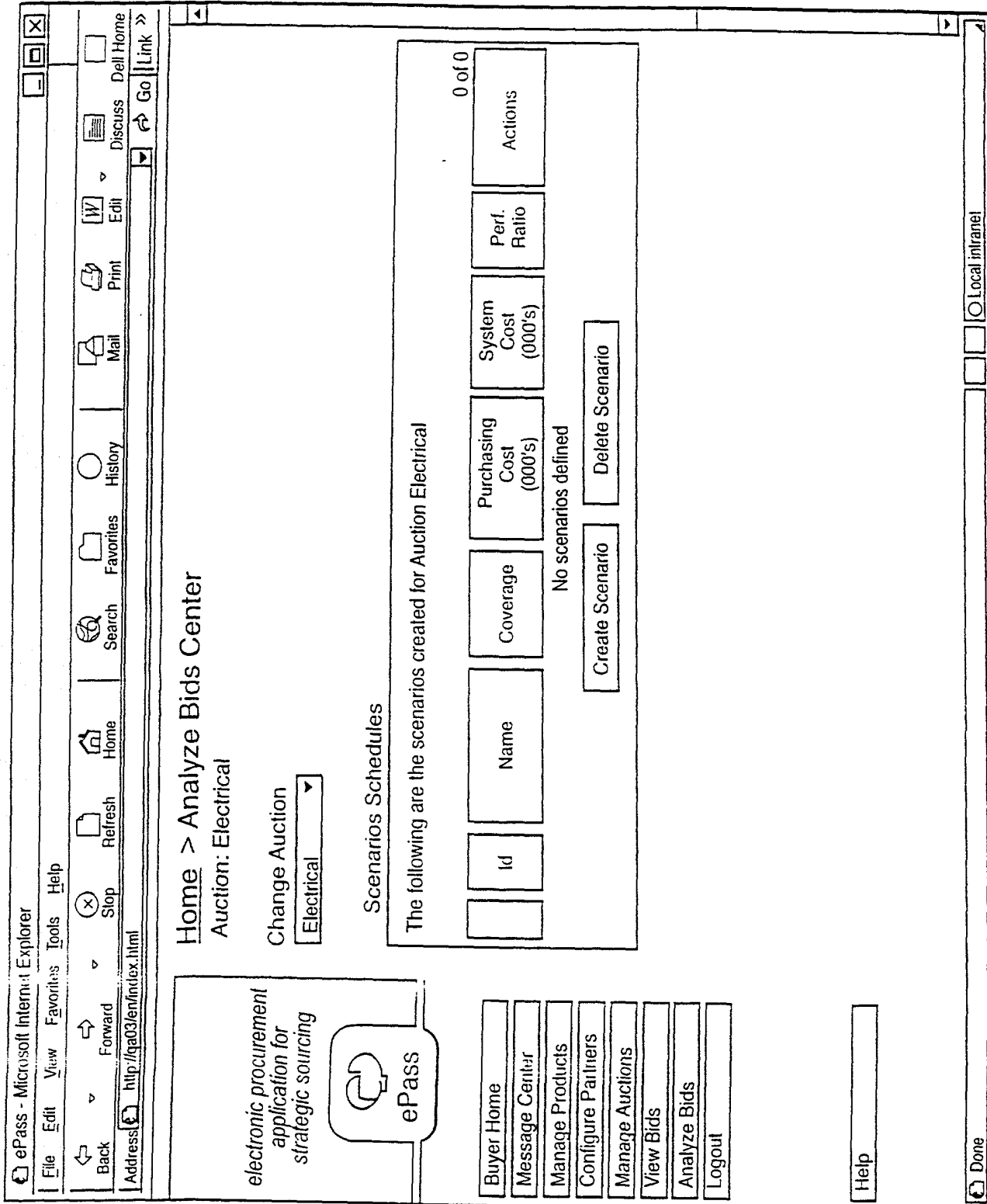


FIG. 22

Microsoft Internet Explorer

File Edit View Favorites Tools Help

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Address http://qa03/en/index.html

Go Link >>

Home > Analyze Bids Center > New Scenario

Auction: Electrical
Scenario:

New Scenario

Please fill in the following information for the scenario.

Name	
Description	
Recommend Secondary Vendors	Lowest Total Cost
Number of Secondary Vendors	2
Rules	<input checked="" type="checkbox"/> Manual Awards <input checked="" type="checkbox"/> Business Rules <input checked="" type="checkbox"/> Bundles
Performance Factor Weightings	
Price	150.00%
Add Factor	Select a Factor

Save Cancel

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[Logout](#)

Help

Done Local intranet

FIG. 23

1 of 1

Home > Analyze Bids > Business Rules

Auction: Electrical
 Scenario: Price Only

Setup Manual Awards Business Rules

The following is a list of business rules defined for scenario Price Only on Auction Electrical

Type	Name	Scope	Partner	Min	Max	Actions
<input type="checkbox"/>	Capacity BR Quantity Limit	RFQ	Each Partner	50%	Wizard	

[Create Rule](#) [Delete Rules](#) [Wizard](#)

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FIG. 24

Microsoft Internet Explorer

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Address http://qa03/en/index.html

Go Link

Business Rule Wizard (Step 1 of 4)

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- Manage Auctions
- View Bids
- Analyze Bids
- Logout

Please name the rule	BR Quantity Limit
Please give a short description	BRQTY
Please give a long description	Limit Vendors to no more than 50% of Bid
Do you want to ignore the rule for now?	<input type="radio"/> Yes <input checked="" type="radio"/> No

Please specify the type of rule

<input checked="" type="radio"/> Capacity	Award business to a preferred Partner of place a limit on the amount of business a Partner is awarded.
<input type="radio"/> Vendor Count	Limit the number of Partners that receive awards
<input type="radio"/> Cost	Limit the purchasing cost (excluding performance based costs)
<input type="radio"/> Performance Cost	Limit the total purchasing cost (including performance based costs)

Next >>

Cancel

Help

Done

FIG. 25

Microsoft Internet Explorer

File Edit View Favorites Tools Help

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Business Rule Wizard (Step 2 of 4)

electronic procurement application for strategic sourcing

ePass

Buyer Home
Message Center
Manage Products
Configure Partners
Manage Auctions
View Bids
Analyze Bids
Logout

Name	BR Quantity Limit
Short Description	BRQTY
Long Description	Limit Vendors to no more than 50% of Bid
Ignore For Now?	No
Type	Capacity

Please specify the scope of the rule

☒ Auction
☐ Requisition
☐ Category
☐ Item

☐ Apply across the entire Auction
☐ Apply only to the specified requisition.
☐ Apply only to the specified category
☐ Apply only to the specified item

[(Each Requisition)]
[(Each Category)]
[(Each Item)]

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Help

Done Local intranet

FIG. 26

Microsoft Internet Explorer

File Edit View Favorites Tools Help

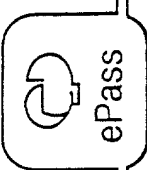
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Business Rule Wizard (Step 3 of 4)

electronic procurement application for strategic sourcing

 ePass

Name	BR Quantity Limit
Short Description	BRQTY
Long Description	Limit Vendors to no more than 50% of Bid
Ignore For Now?	No
Type	Capacity
Scope	RFQ

Please specify the Partner affected by the rule

(Each Partner) Apply the rule to the selected Partner.

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FIG. 27

Microsoft Internet Explorer

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Business Rule Wizard (Step 4 of 4)

Name	BR Quantity Limit
Short Description	BRQTY
Long Description	Limit Vendors to no more than 50% of Bid
Ignore For Now?	No
Type	Capacity
Scope	RFQ
Partner	Each Partner

Please specify the minimum and/or maximum value that should be awarded

Select the units the minimum/maximum value are specified in	<input type="radio"/> Units <input type="radio"/> Dollars <input checked="" type="radio"/> Percentage
Minimum Amount to Award	<input type="text"/> Specify this value if you require the Partner to be awarded a certain amount. You can leave this field blank if there is no required minimum. For percentage, specify 0.5 for 50%
Maximum Amount to Award	<input type="text"/> Specify this value if you want to limit the maximum amount awarded to the organization. You can leave this field blank if there is no maximum. For percentage, specify 0.5 for 50%

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Local intranet

electronic procurement application for strategic sourcing

ePass

FIG. 28

ePass - Microsoft Internet Explorer
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electronic procurement application for strategic sourcing
ePass

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Home > Analyze Bids Center > Setup > Edit Scenario

Auction: Electrical
Scenario: Scene Quality

Edit Scenario

Please fill in the following information for the scenario.

Name	Scene Quality
Description	Price/Quality Analysis
Recommend Secondary Vendors	Lowest Total Cost
Number of Secondary Vendors	2
Rules	<input checked="" type="checkbox"/> Manual Awards <input checked="" type="checkbox"/> Business Rules <input checked="" type="checkbox"/> Bundles
Performance Factor Weightings	
Price	100.00%
Quality	50.00%

Save
Cancel

Done

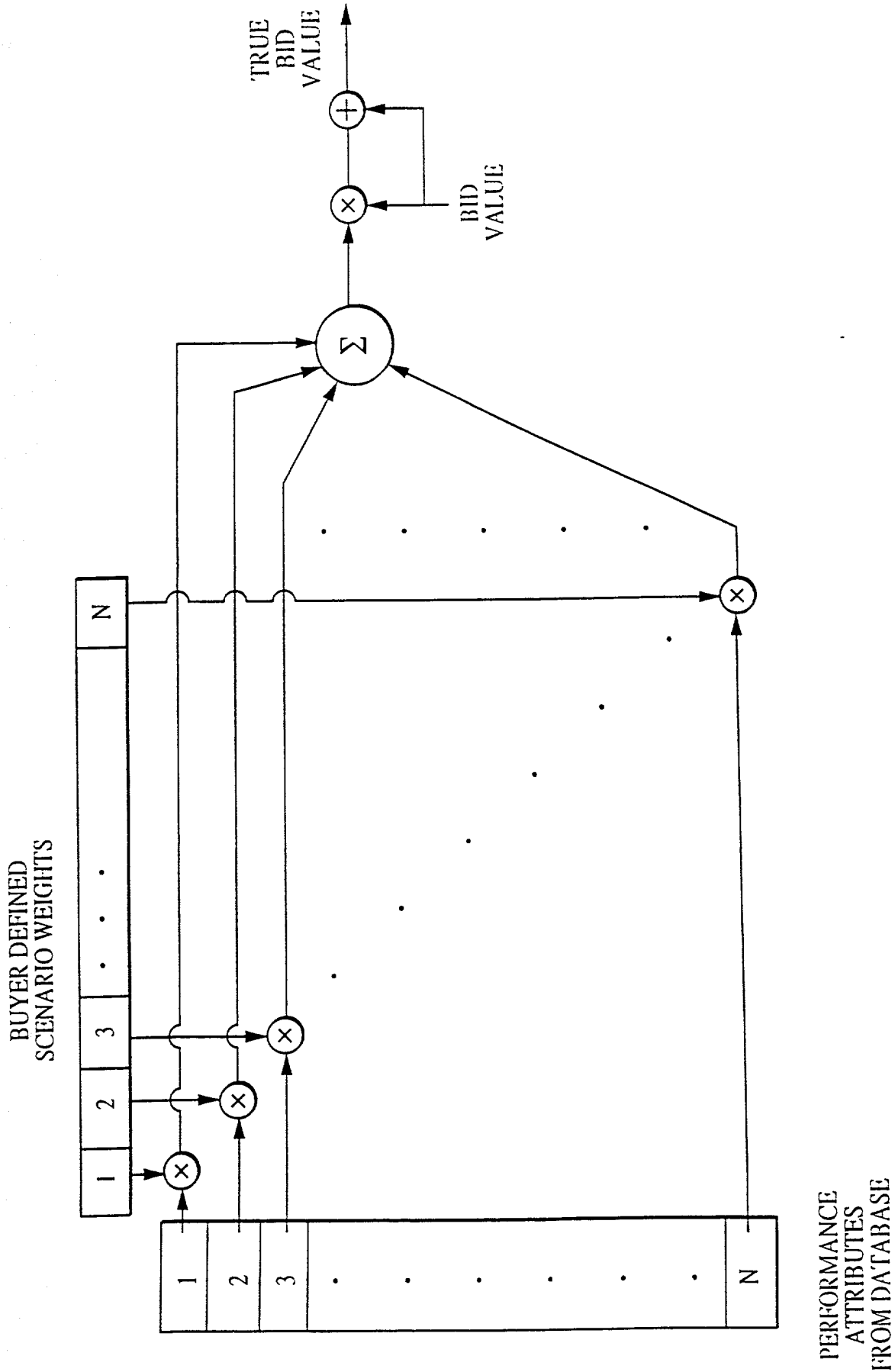


FIG. 29

$$\left(\frac{\text{PRICE}}{\text{TERM}} \right) + \left(\frac{\text{NON-PRICE}}{\text{TERM}} \right) - \left(\frac{\text{BVD}}{\text{TERM}} \right)$$

$$\text{PRICE TERM} = \sum_{s \in S} \sum_{b(s) \in B(s)} \left[f_t^{b(s)} X_t^{b(s)} + C_t^{b(s)} x_t^{b(s)} \right] + \sum_{d(s) \in D(s)} f_t^{d(s)} \sum_{i \in d(s)} Z_t^{d(s)} + C_t^{d(s)} Z_t^{d(s)}$$

$$\text{NON-PRICE TERM} = \sum_{k \in K} \sum_{i \in I} W_{k,i} \left\{ \sum_{s \in S} \left(\frac{100 - r_{k,i}^s}{100} \right) \left[\sum_{b(s) \in B(s)} C_t^{b(s)} x_t^{b(s)} + \sum_{d(s) \in D(s)} C_t^{d(s)} Z_t^{d(s)} \right] \right\}$$

$$\text{BVD TERM} = \sum_{s \in S} \sum_{bvd \in BVD(s)} \sum_{hesag(bvd)} D_{s,bvd}^h I_{s,bvd}^h$$

FIG. 30

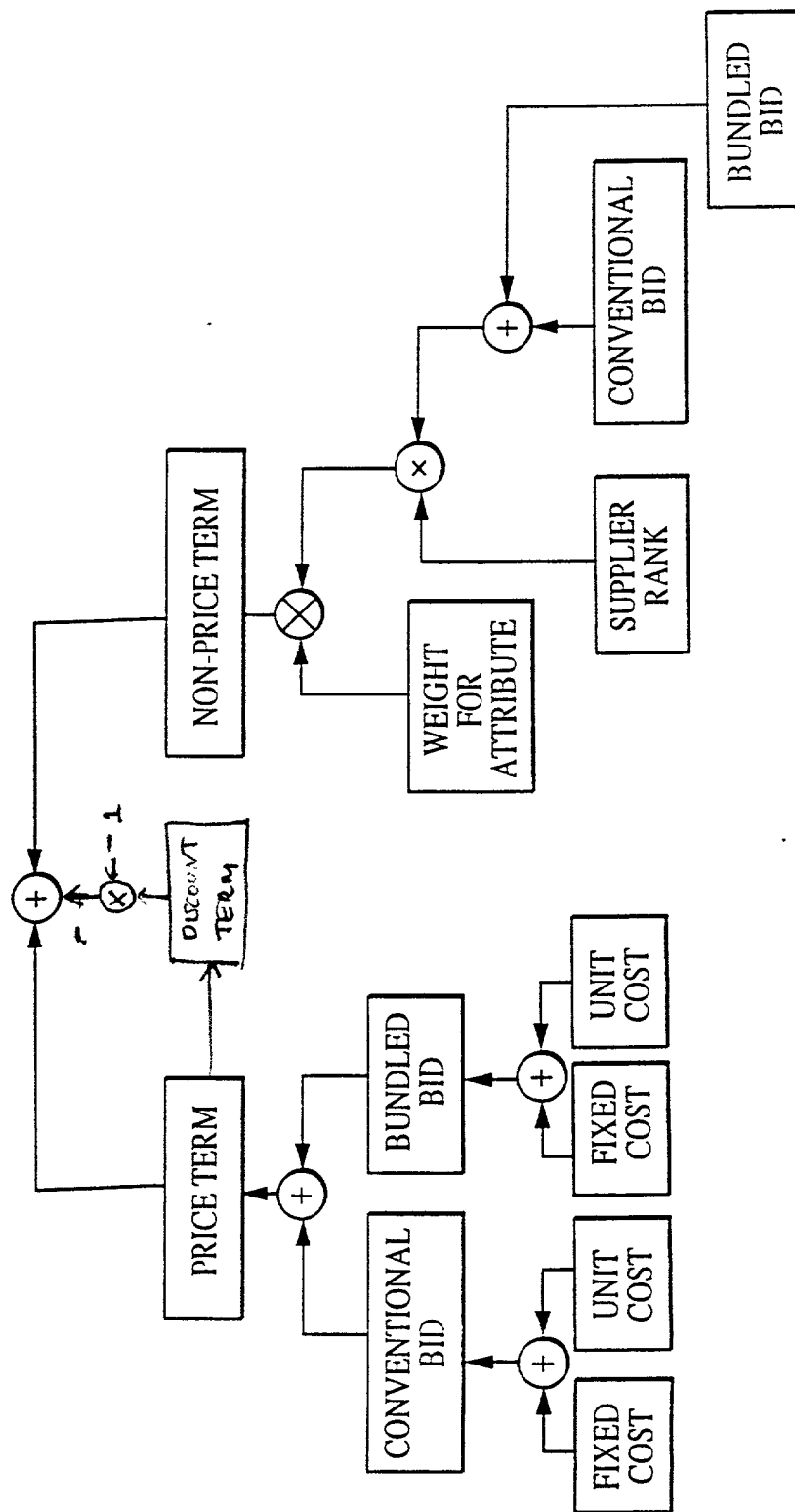


FIG. 31

$$\sum_{s \in S} \left(\sum_{b(s) \in B(s)} x_i^{b(s)} + \sum_{d(s) \in D(s)} z_i^{d(s)} \right) \leq Q_i^u \quad \forall i \in I \quad (1)$$

$$\sum_{s \in S} \left(\sum_{b(s) \in B(s)} x_i^{b(s)} + \sum_{d(s) \in D(s)} z_i^{d(s)} \right) \geq Q_i^l \quad \forall i \in I \quad (2)$$

$$\sum_{i \in g} \left(\sum_{b(s) \in B(s)} x_i^{b(s)} + \sum_{d(s) \in D(s)} z_i^{d(s)} \right) - Y_g^s M_g \leq 0 \quad \begin{matrix} \forall s \in S \\ \forall g \in G \end{matrix} \quad (3)$$

$$\sum_{i \in g} \left(\sum_{b(s) \in B(s)} x_i^{b(s)} + \sum_{d(s) \in D(s)} z_i^{d(s)} \right) - Y_g^s \geq 0 \quad \begin{matrix} \forall s \in S \\ \forall g \in G \end{matrix} \quad (4)$$

$$\sum_{s \in T} Y_g^s \leq \text{Max } N_g^t \quad \forall g \in G, \quad \forall t \in T \quad (5)$$

$$\sum_{s \in T} Y_g^s \geq \text{Min } N_g^t \quad \forall g \in G, \quad \forall t \in T \quad (6)$$

FIG. 32

$$\sum_{s \in I} \sum_{i \in g} \left(\sum_{b(s) \in B(s)} x_i^{b(s)} + \sum_{d(s) \in D(s)} z_i^{d(s)} \right) \leq \text{Max } Q_g^i \quad \forall g \in G, \forall i \in I \quad (7)$$

$$\sum_{s \in I} \sum_{i \in g} \left(\sum_{b(s) \in B(s)} x_i^{b(s)} + \sum_{d(s) \in D(s)} z_i^{d(s)} \right) \geq \text{Min } Q_g^i \quad \forall g \in G, \forall i \in I \quad (8)$$

$$\sum_{s \in I} \sum_{i \in g} \left(\sum_{b(s) \in B(s)} c_i^{b(s)} x_i^{b(s)} + \sum_{d(s) \in D(s)} c_i^{d(s)} z_i^{d(s)} \right) \leq \text{Max } V_g^i \quad \forall g \in G, \forall i \in I \quad (9)$$

$$\sum_{s \in I} \sum_{i \in g} \left(\sum_{b(s) \in B(s)} c_i^{b(s)} x_i^{b(s)} + \sum_{d(s) \in D(s)} c_i^{d(s)} z_i^{d(s)} \right) \geq \text{Min } V_g^i \quad \forall g \in G, \forall i \in I \quad (10)$$

FIG. 33

$$(11) \quad Z_i^{d(s)} - u_i^{d(s)} Z^{d(s)} \leq 0 \quad \forall i \in I, \forall s \in S, \forall b(s) \in B(s)$$

$$(12) \quad Z_i^{d(s)} - l_i^{d(s)} Z^{d(s)} \geq 0 \quad \forall i \in I, \forall s \in S, \forall b(s) \in B(s)$$

$$(13) \quad X_i^{b(s)} - X^{b(s)} U_i^{b(s)} \leq 0 \quad \forall s \in S, \forall b(s) \in B(s)$$

$$(14) \quad X_i^{b(s)} - X^{b(s)} L_i^{b(s)} \geq 0 \quad \forall s \in S, \forall b(s) \in B(s)$$

$$(15) \quad 0 \leq X_i^{b(s)} \leq U_i^{b(s)} \quad \forall s \in S, \forall b(s) \in B(s)$$

$$(16) \quad 0 \leq Z_i^{d(s)} \quad \forall d(s) \in D(s)$$

$$(17) \quad X^{b(s)} = \begin{cases} 0 \\ 1 \end{cases} \quad \forall b(s) \in B(s)$$

$$(18) \quad Y_g^s = \begin{cases} 0 \\ 1 \end{cases} \quad \forall g \in G, \forall s \in S$$

$$(19) \quad Z_g^s = \begin{cases} 0 \\ 1 \end{cases} \quad \forall g \in G, \forall s \in S$$

FIG. 34

$$(20) \quad H_{s,bvd}^U(h) \cdot I_{s,bvd}^h \geq \left[\sum_{\substack{b(s) \in B(s) \\ i \in \text{categories}(bvd)}} f_i^{b(s)} \cdot X_{bvd}^{b(s)} + c_i^{b(s)} \cdot x_{i,bvd}^{b(s)} + \sum_{\substack{d(s) \in D(s) \\ i \in \text{categories}(bvd)}} f_i^{d(s)} \cdot Z_{i,bvd}^{d(s)} + c_i^{d(s)} \cdot z_{i,bvd}^{d(s)} \right] \geq H_{s,bvd}^L(h) \cdot I_{s,bvd}^h$$

$$(21) \quad \sum_{h \in \text{segments}(bvd)} I_{s,bvd}^h = 1 \quad \forall s \in S \quad \text{and} \quad bvd \in BVD(s)$$

$$(22) \quad \sum_{bvd \in \text{COVEREDBYD}(b(s))} J_{bvd}^{b(s)} = 1 \quad \forall s \in S \quad \text{and} \quad b(s) \in B(s)$$

$$(23) \quad \sum_{bvd \in \text{COVEREDBYD}(d(s),t)} J_{i,bvd}^{d(s)} = 1 \quad \forall s \in S, \quad d(s) \in D(s) \quad \text{and} \quad i \in d(s)$$

FIG. 35

$$(24) \quad \begin{aligned} & -M \cdot J_{bvd}^{b(s)} \leq X_{bvd}^{b(s)} \leq J_{bvd}^{b(s)} \cdot M \\ X_i^{b(s)} - M \cdot (1 - J_{bvd}^{b(s)}) & \leq X_{bvd}^{b(s)} \leq (1 - J_{bvd}^{b(s)}) \cdot M + X_i^{b(s)} \end{aligned}$$

$$(25) \quad \begin{aligned} & -M \cdot J_{bvd}^{b(s)} \leq x_{i,bvd}^{b(s)} \leq J_{bvd}^{b(s)} \cdot M \\ x_i^{b(s)} - M \cdot (1 - J_{bvd}^{b(s)}) & \leq x_{i,bvd}^{b(s)} \leq (1 - J_{bvd}^{b(s)}) \cdot M + x_i^{b(s)} \end{aligned}$$

$$(26) \quad \begin{aligned} & -M \cdot J_{i,bvd}^{d(s)} \leq Z_{i,bvd}^{d(s)} \leq J_{i,bvd}^{d(s)} \cdot M \\ Z_i^{d(s)} - M \cdot (1 - J_{i,bvd}^{d(s)}) & \leq Z_{i,bvd}^{d(s)} \leq (1 - J_{i,bvd}^{d(s)}) \cdot M + Z_i^{d(s)} \end{aligned}$$

$$(27) \quad \begin{aligned} & -M \cdot J_{i,bvd}^{d(s)} \leq z_{i,bvd}^{d(s)} \leq J_{i,bvd}^{d(s)} \cdot M \\ z_i^{d(s)} - M \cdot (1 - J_{i,bvd}^{d(s)}) & \leq z_{i,bvd}^{d(s)} \leq (1 - J_{i,bvd}^{d(s)}) \cdot M + z_i^{d(s)} \end{aligned}$$

$$(28) \quad I_{s,bvd}^h \in \{0,1\} \quad \forall s \in S, \quad bvd \in BVD(s), \quad h \in \text{segments}(bvd)$$

$$(29) \quad J_{bvd}^{b(s)} \in \{0,1\} \quad \forall s \in S, \quad b(s) \in B(s), \quad bvd \in \text{coveredbids}(b(s))$$

$$(30) \quad J_{bvd}^{d(s)} \in \{0,1\} \quad \forall s \in S, \quad d(s) \in D(s), \quad bvd \in \text{coveredbids}(d(s), i)$$

FIG. 36